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THE EUROPEAN SPRUCE SAWFLY OUTBREAK
IN 1935.

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TABLE of CONTENTS

	<u>Page</u>
Previous History of Sawfly and Barkbeetle Outbreak -----	1.
Distribution -----	2.
Intensity of Infestation -----	2.
Damage -----	3.
The Future -----	5.
Control and Salvage -----	6.
Parasite Introductions -----	6.

THE EUROPEAN SPRUCE SAWFLY OUTBREAK IN 1935.

This is the fourth of a series of annual reports summarizing briefly our knowledge of the outbreak of the sawfly, in so far as it may be of interest to foresters and woodlands managers. The information has been obtained by the officers of the Forest Insect Division of the Dominion Entomological Laboratory at Fredericton, N.B. Investigations have been carried out at the head of the Cascapedia river in the Gaspé peninsula, at the Parke Reserve of the Quebec Forest Service in Kamouraska county, P.Q., and near Fredericton, N.B. A general survey has also been undertaken in which co-operation has been received from the Quebec Forest Service and the officials of many of the pulp and paper companies, including the Quebec Forest Industries Association Limited. Particular acknowledgment is due to those companies which have obtained samples of the cocoon population, and assisted in parasite liberation work.

PREVIOUS HISTORY OF SAWFLY AND BARKBEETLE OUTBREAK.

The spruce sawfly (Diprion polytomum) was apparently introduced to Canada from Europe. It is probable, however, that it has been in the country not less than fifty years, although it was not discovered until 1930, when it had become very numerous throughout the interior of the Gaspé peninsula and some 2,500 square miles of forest was stripped of over half its foliage. Since then the numbers have increased and the area of heavy attack in which more than half of the foliage was destroyed was estimated in 1934 at 5,000 square miles. This was confined to the Gaspé peninsula, east of the Matapédia valley, but a small area of heavy attack was developing in Kamouraska county, about 100 miles west, and the sawfly was known to be present throughout New Brunswick and northern Maine in considerable numbers, although doing no noticeable damage.

An outbreak of the spruce barkbeetle (Dendroctonus piceaperda) has occurred at the same time, reaching its peak in 1932 and destroying large quantities of the mature spruce. This came to an end in 1934 and mortality from this cause has ceased. It is necessary to separate clearly the effect of the two insects in estimating the present condition in the forest. The barkbeetle appears in periodic sporadic outbreaks, as do many native species. The sawfly outbreak, on the other hand, has persisted in a gradual increase for eight or ten years and appears capable of continuing until reduced by starvation. This is characteristic of the behaviour of introduced species. Also, the methods of attack are quite different. The barkbeetle enters the bark and feeds in the neighbourhood of the cambium; the sawfly eats the foliage. In the former case the tree is generally recognisably dead within a year; in the latter the trees may be attacked for a considerable number of years.

before much damage is apparent and death is a gradual process, often preceded by apparent recovery. Prior to death the trees are generally entered by secondary bark beetles, smaller than D. piceaperda, which feed only in dying trees. Some are attacked by piceaperda itself which acts as a secondary when present in small numbers.

In 1934, a slackening in the actual dying of the trees in the Gaspé was noticed owing to the spruce bark-beetle having ceased its attack. The mortality from sawfly defoliation alone was only just commencing to become apparent. Many trees incapable of recovery were still green.

DISTRIBUTION.

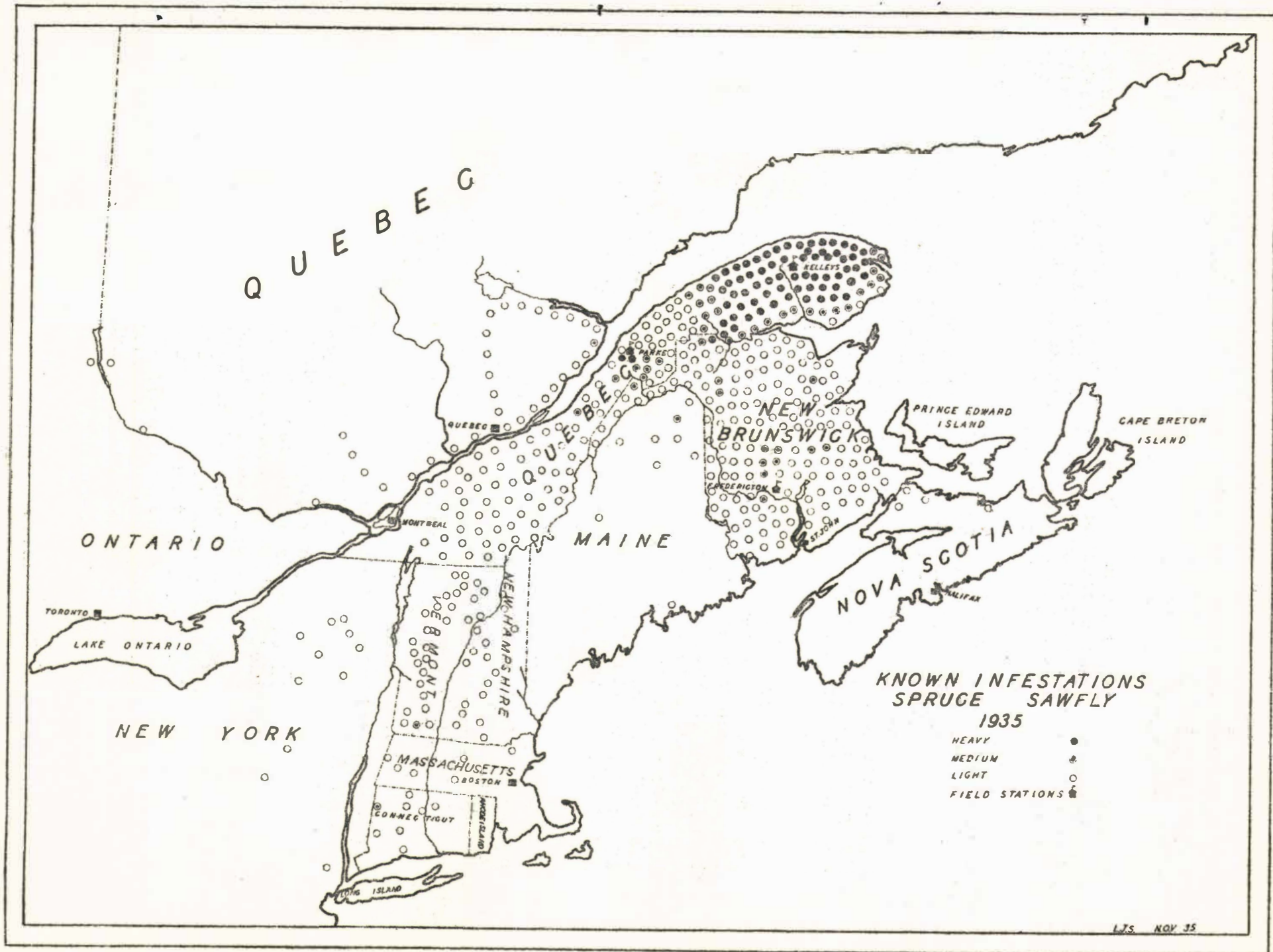
The sawfly has been found this year to be well distributed throughout the spruce forests of eastern Canada and New England. The accompanying map will indicate the points at which it has actually been collected. Information regarding the United States has been obtained from the reports of several entomologists, but chiefly from Dr. H. J. MacAloney, of the U. S. Bureau of Entomology and Plant Quarantine, who very kindly supplied a list of localities where he discovered the larvae in a survey in 1935.

It will be seen that the insect is well established on the north side of the St. Lawrence and is present at least as far north as Lake St. John. It has been found as far west as Lake Temiskaming in Ontario, as far east as Pictou, Nova Scotia, and as far south as Orange, Conn. We have collected the larvae with ease at all points in New Brunswick where this has been attempted and it is no doubt present throughout Maine. In Nova Scotia, however, we have not been able to find it as yet outside of Cumberland and Pictou counties. The sawfly occurs at all elevations from sea level up to timber line.

Such a wide distribution of a species presumably introduced from Europe would suggest a considerable power of dispersal. That the adults are capable of travelling long distances is borne out by our observations on flight. It has been proved that they can fly well over a mile and there is little doubt that they often fly several miles. Aided by air currents, they might even travel much farther.

INTENSITY OF INFESTATION.

The heavily infested area is indicated on the map and will be seen to be confined almost entirely to the Gaspé, where it now covers close to 6,000 square miles. The attack has destroyed the greater part of the foliage over this area and on most of it there is little or none of the old foliage left and a good deal of the new foliage was eaten in 1935. Throughout this region the scarcity of foliage has for the past two years caused a reduction in the cocoon population. Our figures in one place show a reduction of over 50 per cent since 1933. The loss of larvae through starvation and the effects of scarcity of foliage on oviposition have prevented the new generations from adding enough cocoons to the ground to make up for those eaten by shrews, mice, and squirrels, or dying from other causes.



On the other hand, the proportion of sound cocoons to available foliage has probably increased rather than decreased and our samples still show an average of around 13 sound cocoons to the square foot, with the sound cocoons equalling in number those from which flies have emerged during the past seven or eight years. With the dying of the trees the insects will be concentrated on the remainder and the attack will continue to be severe.

At the centre of the small area of heavy attack in Kamouraska county, conditions were peculiar in 1934 in that 98 per cent of the larvae remained dormant in the cocoon throughout the year. The trees were able to recover part of their lost foliage by new growth and the cocoons were reduced in numbers by about 30 per cent. In 1935, however, a more normal emergence of about 20 per cent took place, the infestation was severe, some of the trees were completely defoliated and the cocoon population was built up to about 25 sound cocoons per square foot. The increase was greatest beneath the black spruce because there was less scarcity of foliage on them. An increase in the larval population was noted throughout the whole of this general area, although severe defoliation was confined to a few square miles near the Parke Reserve where some of the trees are already dead.

In New Brunswick, conditions have varied from place to place but in general there has been an increase in the population, particularly in the central part of York county. In some of the white spruce stands the trees show evidence of defoliation from the ground and the excrement of the larvae is noticeable beneath the trees. Near Fredericton, our samples show only one sound cocoon every two square feet, less than last year. A few miles north, however, a hundred or more larvae occurred on each tree in the summer and nearly two sound cocoons per square foot were found in the fall.

In general, it may be said that the infestation of larvae per tree during 1935 was greater at most points of observation than in previous years, although local exceptions occurred where the population showed little change or some reduction.

DAMAGE.

The damage up to date may be considered as consisting of; Death due to bark beetle attack, death without bark beetle attack, loss of foliage and growth sufficient to make recovery very unlikely, and loss of foliage and growth not sufficient to cause death but making the trees less resistant to further attack.

Cruise lines were run by Mr. M. L. Prebble over the same ground on the headwaters of the Cascapedia and Ste. Anne rivers as in previous years. Although it was possible to tally only 23.4 acres, analysis indicates that the figures are reasonably significant for the localities studied and general observations suggest that they are representative of much of the interior of the Gaspe peninsula.

The lines were run across the valleys

as far up the slopes as white spruce of merchantable size occurred. They did not include the black spruce slope type or other steep, more or less inaccessible, slopes. The average stand per acre was 32 cords. The average percentage composition was as follows:

<u>Species</u>	<u>% by Stems</u>	<u>% by Volume</u>
Balsam fir	62.5	46.6
White spruce	25.6	41.5
Black spruce	8.4	7.9
Birch	3.5	4.0

The condition of the spruce is shown in the following tables.

Species	<u>% Dead</u>				<u>% Living</u>			
	<u>Attacked by Dendroctonus</u>		<u>Not attacked by Dendroctonus</u>		<u>Recovery Impossible.</u>		<u>Recovery Possible if not injured further</u>	
	<u>Stems</u>	<u>Vol.</u>	<u>Stems</u>	<u>Vol.</u>	<u>Stems</u>	<u>Vol.</u>	<u>Stems</u>	<u>Vol.</u>
White Spruce	24.3	44.5	8.5	7.7	38.2	27.6	29.0	20.2
Black Spruce	6.3	9.7	8.0	11.7	12.5	12.3	73.2	66.3

To summarize: About 52 per cent of the volume of the white spruce is dead, 28 per cent is practically certain to die, 20 per cent might recover if the attack stopped. Of the black spruce, 22 per cent is dead 12 per cent beyond recovery, and 66 per cent capable of recovery failing further injury.

Judging from other plots and general observations, these figures are a fair estimate of the damage. There are some localities on the northern side of the peninsula where the mortality is higher, but there are also areas in the more southerly part of the heavily infested region where it is less.

On the black spruce slopes there is a mortality of around 20 per cent. Black spruce flats, though becoming more heavily defoliated, have as yet suffered no mortality.

At a number of points near the coast and along the Matapedia valley, young stands have been severely attacked and a considerable proportion of the trees killed. Some are old field stands of pure white spruce, others are white spruce mixed with hardwoods. Many of these trees have died while still retaining most of their new foliage. Young and vigorous trees are often more easily killed than slower growing trees.

Increment studies show that many of the heavily defoliated white spruce have not formed complete annual rings for two years and the majority did not put on a complete ring in 1935.

THE FUTURE.

No sound reasons have as yet appeared for expecting anything but a continuation and gradual extension of the outbreak. The sawfly appears to be adapted to maintaining itself in destructive numbers throughout the range of our spruce forests. In the Gaspé it confines itself to one generation, the very great part of which successfully reaches the hibernation stage before snow. In New Brunswick there are two successful generations to fit in with the longer season, and further south there are probably three.

The feeding stages survive practically all extremes of high or low temperature which our climate offers, except in the case of some of the stragglers in the autumn. The hibernating stages, although unable to survive -20° F., are invariably protected by snow. No very important mortality resulted from temperatures as high as 100° F. during the past summer.

Small mammals are an important check but appear to be incapable of destroying more than half the cocoons and this only when the latter are already numerous. There are no other predators of much importance.

Native parasite attack is still lacking and it is in the establishment of European species to supply this lack that the best hope of a reduction in the outbreak lies. Although it will be probably some time before any definite indication of the success of the species liberated during the past year can be obtained, it is encouraging that three of them have been recovered.

While it is possible that natural factors of control may appear which will check the increase in numbers outside of the Gaspé, we have not been able yet to discover any which are likely to be permanently effective in preventing damage. At the same time, the habit of going into dormancy for several seasons is a protection against sudden decimation by climatic factors. We know now that some emerge after lying dormant for five years. On the other hand, however, this habit reduces the rate of increase and tends to make the development of an outbreak more gradual, though more certain.

The white spruce which is still living in the heavily infested area is, as indicated in previous reports, in danger of more or less complete destruction. A good deal of the black spruce will probably be killed, but whether the sawfly will be capable of continuing its attack until the black spruce is all destroyed is still uncertain.

Outside of the Gaspé, actual killing of trees is unlikely in the near future, except on restricted areas. The population is, however, already quite large in many places and with favourable seasons a rapid increase to tree-killing proportions is possible within a few years, especially in the two-generation

region. At present, this danger is greatest where white spruce is the predominating species and where the stands are mature. Young stands and red spruce are, however, also subject to severe attack and the mistake should not be made of considering this species as an enemy only of mature or over-mature stands.

CONTROL AND SALVAGE.

As emphasized in previous reports, plans for salvage, wherever possible, should be made immediately in the heavily infested area, especially if the spruce is to be used for lumber. Large areas of the Gaspé forests, if not salvaged, will become unfit for operation owing to the serious reduction of merchantable stand per acre. This, together with blowdown and increased fire hazard, will render economically inaccessible a good many millions of cords, some of which can be profitably cut at the present time.

Clean cutting of all species is recommended as reproduction is adequate in this region. Any spruce left would be attacked more severely than ever and the balsam fir would be very subject to windfall. Decay will apparently not be a serious factor, as far as pulpwood is concerned, for several years after death.

The only direct method of controlling the insect is by the application of poison dust from aeroplanes. Owing to the cost, and the fact that re-infestation will take place from neighbouring forests and from dormant larvae in the ground, this method can be considered only where the trees have a special value.

PARASITE INTRODUCTIONS.

For the past three years the Dominion Entomological Branch has been engaged in the introduction, rearing, and liberation of parasites of the sawfly from Europe. These parasites are collected in co-operation with the Farnham Royal Laboratory of the Imperial Institute of Entomology and forwarded to the Dominion Parasite Laboratory, where pure cultures of the adults are reared under the direction of Mr. A. B. Baird and shipped to the field for liberation. The liberations have been largely made by Mr. L. J. Simpson. Financial and other assistance has been given by the Quebec government and by those companies owning limits in the Gaspé through the Quebec Forest Industries Association, Limited.

These parasites are insects which live only on other insects. The larval stages feed in or upon the sawfly larva, finally killing it and emerging from its cocoon as adult winged parasites which lay their eggs in more sawfly larvae. They will attack, as a rule, only a small number of species of sawfly. As the different species of parasite have very different habits, they vary considerably in their effectiveness under different conditions. It is impossible to say what will be the result of introducing a parasite to a new geographical area. It may fail to establish itself. It may succeed in establishing itself but be unable to increase its numbers sufficiently to control its host. It may not only establish itself but be capable of increasing more rapidly than its host. In the latter case it will eventually reduce the numbers of the

destructive insect and if sufficiently well adapted to the environment, keep it permanently in check below the level where damage is done.

For these reasons it is necessary to test out in the field as many species as can be secured, whose habits offer some promise of their being successful under our conditions. The final result cannot be determined until they have been given time to establish themselves and multiply sufficiently to demonstrate their effectiveness. It may be that a combination of different parasites is necessary. It is also probable that different species will be most effective in different regions, according to the climate, number of generations, presence of alternate hosts, etc.

During 1935, two and a half million parasites were liberated, of which the majority were the species Microplectron fuscipennis, a very small wasp attacking the cocoon, which it has been found possible to multiply in the laboratory. The remainder, about 275,000 consisted of twelve other species, some attacking the egg, some the feeding larvae, and some the dormant larvae. In some cases only a few hundred specimens have been secured and these have been placed in special cages to assist them in becoming established. Of the districts in which liberations were made, eighteen were in Quebec, south of the St. Lawrence river; eleven were north of the river; and five were in New Brunswick.

The initial success of these liberations can only be estimated by collecting sawfly cocoons near the points of liberation and rearing them to see if any are parasitized. Owing to dispersal of the parasites, high percentages of parasitism are not likely to be found for a number of years and at the present time the point of chief interest is what species can be recovered at all. Collections made in 1935 cannot be reared for parasitism until next season. From the collections made in 1934, however, a few specimens of three species were recovered: Microplectron fuscipennis, Microcryptus basizonius, and Exenterus marginatorius. This proves that these three can attack the sawfly and produce a second generation in our forests. No assurance can be given, but we hope that in time one or more of these parasites will be found to be an effective controlling agent of the sawfly. In any case, the addition of these beneficial species to our forest fauna cannot fail to be of permanent value.

Dominion Entomological Laboratory
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For the 1934 report, see the Annual Report of the Department of Lands and Forests of Nova Scotia, 1934, p. 84.

An illustrated description of the sawfly is available on request.
